

**Functional Asymmetrical Circuit Substrate Assembly**  
**Including a Mirror-Symmetrical Component Layout**

The present invention relates to a circuit substrate assembly comprising pairs of „left-hand“ and „right-hand“ circuit substrates including electrical and/or electronic and/or electromechanical components positioned mirror-symmetrical to each other, it relating more particularly to circuit substrate assemblies as set forth in the preamble of claim 1 as known from DE 39 04 771 C1, DE 44 05 566 A1 and US 5,612,777 in each case.

The objective forming the basis of the present invention is explained, by way of an example, with reference to Figs. 3a to 6b.

For controlling car door locks, use is made nowadays of electromechanical locking devices. Shown diagrammatically in Figs. 3a or 3b is a plan view of the open pans 1, 1' of a circuit substrate 2, 2' for a left-hand and right-hand car door respectively.

The circuit substrates 2, 2' are plastics substrate parts in which electric conductors are embedded which connect the electrical and/or electronic and/or electromechanical components to each other on the two circuit substrates 2, 2'.

In Figs. 3a and 3b the components applied to the two circuit substrates 2 or 2' are, for example, a first switch SW1 or SW1', a second switch SW2 or SW2', a first electric motor M1 or M1', a second electric motor M2 or M2' and a

plug S or S'. The electric motors are each symbolized by the contact terminals and the direction of rotation of the motor.

5 In series automobile production the situation calls for configuring the two circuit substrates 2, 2' and their pans 1, 1' as shown in Figs. 3a and 3b for a left-hand and right-hand car door mirror-symmetrical to permit installing them on both sides of the motor vehicle positioned and  
10 oriented mirror-symmetrical to each other.

When imagining that a mirror plane P is oriented between the left-hand and right-hand variants of a circuit substrates 2, 2' as shown in Figs. 3a and 3b, then due to  
15 the symmetry requirements the positions and orientations of the components mounted on the left-hand circuit substrate 2 are mirror-symmetrical to the positions and orientations of the components mounted on the right-hand circuit substrate 2'.

20 It is particularly in series motor vehicle production that for reasons of simplifying material economy and cost savings in designing the variants there exists the marginal requirement that the number of component variants to be  
25 developed and held available is to be minimized. This means, for example, that no specific left-hand and specific right-hand variant is to be provided in each case for the components as shown in Figs. 3a and 3b. By making use of only one variant of components the complexity requirements  
30 in installation and on the corresponding automated handling devices are also reduced in each case.

Instead, what is desired in series production is that the motors M1 and M2, the switches SW1 and SW2 and plug S as  
35 shown in Fig. 3a and all totally identical to the motors

M1' or M2', the switches SW1' and SW2' and plug S' as shown in Fig. 3b.

Accordingly, as regards their circuit-functional contact  
5 assignment and effectiveness, the components as shown in  
Figs. 3a and 3b are not mirror-symmetrical to each other,  
i.e. the identical motors M1 in Fig. 3a and M1' in Fig. 3b  
both rotate counter-clockwise, for example (and not  
opposite in rotation to each other) and the plug positions  
10 plug positions A-K of the plugs S or S' as shown in Figs.  
3a and 3b are likewise not mirror-symmetrical to each  
other, they instead corresponding to each other.

In other words, mirror-symmetry exists as regards the  
15 three-dimensional geometry of the installation situation  
for the left-hand and the right-hand variant of the circuit  
substrate, whereas asymmetry exists as regards the  
functionality of the circuit.

20 Due to the components being identical as shown in left-hand  
and right-hand configuration this also results in, in the  
case of car door locking devices, that for the mating the  
plugs and the wiring harnesses connected thereto a left-  
hand and right-hand variant does not need to be provided in  
25 each case, but instead only an identical variant to be  
installed on the left-hand and right-hand side of the  
vehicle as regards its symmetrical positioning and  
orientation in a three-dimensional geometry, but which is  
asymmetrical as regards its circuit functionality.

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Since both circuit substrates as shown in Figs. 3a and 3b  
are assigned exactly the same circuit diagram and the same  
contact pin assignment, as shown in Fig. 4 for example, two  
different layouts for the circuitry need to be designed for  
35 the circuitry in the left-hand and right-hand embodiment of

the circuit substrates 2, 2' for correctly contacting the left-hand and right-hand variant of the circuit substrates 2, 2' in accordance with the circuit function.

5 Satisfying this requirement hitherto in actual practice was achieved by selecting a layout for the left-hand circuit substrates 2 different to that for the right-hand circuit substrates 2', as evident from Figs. 5a and 5b each showing a layout for a left-hand and a right-hand circuitry.

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Referring now to Figs. 6a and 6b there is illustrated, the same as shown in Figs. 3a and 3b, how the circuitry as shown in Figs. 5a and 5b is embedded in the circuit substrates 2, 2' which is usually done by potting the circuit substrates in plastics.

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When using e.g. a stamped matrix for the circuitry, then the layouts as shown in Figs. 5a and 5b correspond to two different stamped matrixes, each of which is to be embedded in the left-hand and right-hand circuit substrates 2, 2' respectively, this requiring, of course, two different stamping/bending dies for producing the stamped matrixes. In automated production this results in two production lanes totally separate from each other needing to be equipped including stamping/bending dies and automated handling devices each specifically adapted to the left-hand and right-hand stamped matrix. By making use of different stamping/bending dies for the left-hand and right-hand stamped matrix it is possible to configure on the two stamped matrixes, by suitably bending the free-standing stamped matrix sections, contact pins (not shown) permitting contacting the components to the two stamped matrixes as shown in Figs. 6a and 6b such that the components are positioned mirror-symmetrical to each other on the left-hand and right-hand stamped matrix.

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Similar problems are likewise involved when using circuit substrates with applied track arrays, e.g. in the form of of rigid circuit boards or flexible printed circuit films instead of stamped matrixes. Here too, two variants having different circuitry (layouts) needs to be provided for the left-hand and right-hand embodiment in the case of such circuit substrates provided with tracks, meaning that, e.g. two different kinds of exposure masks need to be employed in photolithographic circuit board production.

In any case, the problem remains of having to handle two different variants of the circuitry in series production, as a result of which the objective of minimizing the variants of the components employed and the complexity in handling fails to be attained optimally.

Although only one circuit substrate is involved when using circuit substrates having two different layouts for the circuitry applied to both sides (e.g. as in the case of a double-sided circuit board provided with tracks on both sides or a double-sided flexible circuit film printed on both sides) this still needs to be provided with tracks on both sides which, depending on the method employed in each case, may considerably add to the complexity in production and thus the costs involved.

It is thus the objective of the present invention to propose a circuit substrate assembly comprising a left-hand and a right-hand circuit substrate including electrical and/or electronic and/or electromechanical components positioned mirror-symmetrical to each other in which the number of component variants needing to be made available for series production including the number of variants of

the circuitry for the left-hand and right-hand circuit substrate is a minimum.

This objective is achieved by the means as provided for in claim 1. The dependent claims relate to advantageous embodiments of the present invention.

In addition to the series production of circuit substrates for electromechanical car door locks, the same problem situation exists in the requirement for circuit substrates symmetrical in three-dimensional geometry as regards component positioning but asymmetrical as regards the circuit functionality of these symmetrically positioned components likewise e.g. in the series production of circuit substrates for left-hand and right-hand car seat adjustment, in the series production of vehicles having left-hand or right-hand drive or quite generally in any situation where a left-hand variant and a right-hand variant mirror-symmetrical thereto as regards the three-dimensional geometry of a circuit substrate needs to be produced in making use of but a single type of electrical and/or electronic components.

The advantages and features of the present invention will now be detailed by way of example embodiments as described in the following with reference to the drawings in which

FIG. 1a is a plan view of the left-hand variant of circuit substrate in accordance with the invention including the circuitry integrated therein;

FIG. 1b is a plan view of a right-hand circuit substrate corresponding to the left-hand circuit substrate as shown in Fig. 1a;

Figs. 2a and 2b

are plan views of a left-hand and right-hand variant respectively of the circuitry as shown in Figs. 1a and 1b respectively each in the form of a stamped matrix,

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Figs. 3a and 3b

are plan views of a left-hand and right-hand variant respectively of a circuit substrate to assist explaining the objective forming the basis of the invention as well as the components applied thereo, the assigned circuitry being concealed:

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Fig. 4 is a diagrammatic illustration of a circuit diagram and a plug contact assignment of a plug for the left-hand and right-hand variant respectively of a circuit substrate as shown in Figs. 3a and 3b:

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Figs. 5a and 5b

are plan views of a left-hand and right-hand variant of conventional circuitry in the form of stamped matrixes for use in the circuit substrates as shown in Figs. 3a and 3b respectively;

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Figs. 6a and 6b

are views corresponding to those as shown in Figs. 3a and 3b showing the circuitry integrated in the two circuit substrates as shown in Figs. 5a and 5b;

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Fig. 7 is a plan view of a plug used preferably on a circuit substrate assembly in accordance with the invention including two rows of terminals arranged juxtaposed in parallel; and

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Figs. 8a and 8b

are views in perspective of left-hand and right-hand variants of a single-sided conductor substrate for use in the circuit substrate assembly in accordance with the invention in the form of a rigid circuit board or a flexible circuit film with a plated-through track plane.

Referring now to Figs. 1a and 1b there is illustrated a circuit substrate assembly in accordance with the invention comprising a left-hand 2 and a right-hand circuit substrate 2' arranged mirror-symmetrical thereto as regards its three-dimensional geometry along a mirror plane P. Electrical and/or electronic and/or electromechanical components such as switches SW1 or SW1', SW2 or SW2', electric motors M1 or M1', M22 or M2' and contact plugs S or S' are positioned in a pan 1, 1' on the embedded stamped matrix in the circuit substrates 2, 2', all electrically in contact with the stamped matrix.

In the left-hand and right-hand variant of the circuit substrate 2, 2' these components are positioned and oriented mirror-symmetrical to the mirror plane P.

It is to be noted, however, that precisely the same components are used in each case in the left-hand and right-hand circuit substrate. The switch SW1 on the left-hand circuit substrate is thus identical to the switch SW1' on the right-hand circuit substrate, switch SW2 on the left-hand circuit substrate is thus identical to the switch SW2' on the right-hand circuit substrate, the same applying to the electric motors M1 or M1' as well as M2 or M2', each of which turns in the left-hand and right-hand variant of the circuit substrates 2, 2' in the same direction of rotation (counter-clockwise) and not contrary to each



other. Furthermore, the contact assignments A to K or A' to K' of the plugs S and S' respectively are not applied mirror-symmetrical to each other. Instead, the plug S' on the right-hand circuit substrate 2' can be imagined to materialize from the plug S on the left-hand circuit substrates 2, such that the plug S as shown in Fig. 1a is shifted to the right about the arrow a by a translational shift perpendicular to the mirror plane P.

10 The left-hand circuit substrate 2 as shown in Fig. 1a and the right-hand circuit substrates 2' as shown in Fig. 1b are thus mirror-symmetrical as regards a three-dimensional geometry, but due to the motors rotating in the same sense and due to precisely the same contact assignments A to K on the two circuit substrates are asymmetrical to each other in circuit functioning.

The two circuit substrates 2, 2' as shown in Figs. 1a and 1b comprise circuitry 3 or 3' in the form of electrically conducting stamped matrixes as evident from Figs. 2a and 2b, whereby precisely identical stamped matrixes are inserted in both circuit substrates 2, 2'. The stamped matrix inserted in the right-hand circuit substrates 2 thus materializes from the stamped matrix used in the left-hand circuit substrate by mirroring at the mirror plane P.

This thus enables resort to be made to a single type of stamped matrix which when used in the left-hand circuit substrate is componented on a predefined side and when used in the right-hand circuit substrate is componented on the opposite side for good material economy.

Where a metallic stamped matrix is concerned in which the matrix sections are totally electrically conducting and can thus be electrically contacted, this is done by soldering

or bonding or welding the contact pins or contact tags of the components to one side of a stamped matrix or respectively to the opposite side. By making use of two stamped matrixes symmetrical to each other only one  
5 stamping die needs to be made available.

Referring now to Figs. 2a and 2b the black circles 9 and 9' respectively identify positions at which the the terminal contacts of the components as shown in Figs. 1a and 1b  
10 (plugs S or S', motors M1, M2 or M1', M2' and switches S1, S2 or S1', S2') are connected to the stamped matrixes. Preferably the left-hand and right-hand variants of the stamped matrix are each provided at these points 9, 9' with contact pins or contact tags by a step in production to be  
15 implemented separate for both variants, as achievable by the usual methods of welding, soldering or in principle also by bonding contact pins or contact tags. The contacts of the components can then be connected to the prefabricated stamped matrixes by particularly simple ways  
20 and means.

Due to using identical plugs S or S' and motors in series production of car door locks particular attention is to be paid to the requirement of functional asymmetry as regards  
25 the plugs and motors mounted on the left-hand and right-hand circuit substrates respectively.

To minimize problems in configuring the layout of the circuitry for a circuit substrate assembly in accordance  
30 with the invention the array for the contact terminals of a plug S or S' as shown in Fig. 7 and the contacting sections of the circuitry for a circuit substrate assembly in accordance with the invention is preferably selected:

As evident from Fig. 7 a plug S is provided with plug  
35 contacts A to K arranged in two rows juxtaposed in

parallel, i.e. a first row of plug contacts A to E and a second row of plug contacts F to K. The contact terminals a to e assigned to the first row of plug contacts A to E are arranged offset by a distance  $x$  relative to the second row of contact terminals f to k assigned to the plug contacts F to K.

Now, in defining a layout for a circuitry to be employed in a circuit substrate assembly in accordance with the invention the circuitry sections 10 and 11, 12 and 13, 13 and 14 (Fig. 2a) corresponding to the plug contacts A and F, B and G, C and H are likewise arranged in two rows juxtaposed in parallel to each other, as evident from Figs. 1a and 1b respectively, i.e. so that below a pair of plug contacts A and F, B and G, C and H two circuitry sections each run parallel to each other. By arranging the circuitry sections in this way, it is assured that the left-hand variant, in which the plug S contacts the stamped matrix at a first side, as well as in the right-hand variant „flipped“ relative thereto in which the corresponding plug S' contacts the opposite side, as provided for in the circuit diagram (Fig. 4) can be connected. In the present example in accordance with the circuit diagram as shown in Fig. 4 the plug contacts D and I, E and K are not contacted.

This arrangement ensures that all contact terminals a,b,c,f,g,h of the plug contacts A to C as well as F to H of the plug to be contacted are able to enter into contact with the circuitry sections 10 to 15 (Fig. 2a) on the circuitry 3 , 3' on both the left-hand circuit substrate 2, as shown in Fig. 2a as well as on the circuit substrate 2', flipped 180° thereto as shown in Fig. 2b (i.e. mirrored at the mirror plane P), in other words the right-hand circuit substrate 2'.

Instead of a stamped matrix, which when used in a right-hand circuit substrate instead of in a left-hand circuit substrate is to be mirrored at a mirror plane and to be  
5 directly contacted with components double-sided, it is now possible in a circuit substrate assembly in accordance with the invention to use rigid circuit boards or flexible circuit films provided with tracks only on one side. This is evident from Figs. 8a and 8b, illustrating in  
10 perspective two identical circuitry substrates 4,4' provided single-sided with tracks in a circuit substrate assembly in accordance with the invention oriented for use in a left-hand and a right-hand circuit substrate.

15 Shown in Fig. 8a is a conductor substrate 4 provided single-sided with tracks for use in a left-hand circuit substrate. Shown in in Fig. 8b is a conductor substrate totally identical to the conductor substrate as shown in Fig. 8a for use in a right-hand circuit substrate. The  
20 conductor substrate as shown in Fig. 8b can be imagined as the conductor substrate as shown in Fig. 8a flipped 180° longitudinally about the axis shown between the two conductor substrates.

25 The conductor substrate 4, 4' is provided with through-holes 5 on its tracks where components are to be applied, the through-holes 5 being through-plated for this purpose, thus making it possible to component the conductor substrate 4 double-sided, although provided only single-  
30 sided with tracks. This thus enables conductor substrates provided only single-sided with tracks to be employed for both left-hand and right-hand circuit substrate variants in a circuit substrate assembly in accordance with the invention.

